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The Management of Benign Bone Lesions

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The almost bewildering variety of lesions that can affect bone contrasts sharply with the limited potential of bone to differentially respond to those lesions. This paradox can create a challenging problem when a bone lesion is shown on an x-ray film. Although heavily populated with pleuripotential primitive mesenchymal cells, there is seldom a histologic or radiographic change in the involved bone specific enough to allow a comfortable diagnostic autonomy to be enjoyed by surgical pathologists, radiologists or orthopaedic surgeons. Even when diligent and astute clinical evaluation has excluded infectious, parasitic, metabolic and metastatic causes of the change seen on x-ray studies, a physician is often still uncertain as to the exact nature of the lesion. A knowledge of the relative frequency of the common lesions, an acceptance that biopsy studies and treatment must be combined at times, an appreciation of the possibility of malignant change in a given lesion and a tendency to seek early consultation will likely lead to timely and accurate diagnosis. Once the diagnosis is made, optimum management must be selected. The best current opinion categorizes the lesions into treatment groups consisting of observation, curettage and graft, block excision, cryotherapy and radiotherapy.

ELECTRON MICROSCOPY, angiography and histochemical studies continue to contribute to the understanding of benign bone lesions. This type of information is valuable in view of our limited knowledge of these lesions but is not yet clinically helpful except in contributing to diagnostic certainty and providing a basis for controversy. The underlying nature of these lesions, often loosely called "tumors," is uncertain both for the true neoplasms and the other lesions which may closely resemble them radiographically. Because some of the benign bone lesions are seen infrequently even in large centers, clinical studies have necessarily been retrospective, and valid patterns of natural history emerge slowly. Concepts of management of benign bone tumors are therefore changing and information with which to develop an appropriate plan of management of a particu-

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lar lesion is not always readily available. A schema has been developed that reflects current opinion and can be used as a general guide to clinical management.

"Tumor" Entities

From a pragmatic viewpoint, the list of benign "tumors" of bone will necessarily include a wide variety of lesions, even if the metabolic, inflammatory and dysplastic lesions are excluded (Table 1).

In Table 1 the more common benign bone "tumors" are listed on the left in rough order of descending frequency. Parosteal or juxtacortical variants are excluded for brevity.

Fibrous cortical defects are certainly the most common.[1-5] One or more fibrous cortical defects (or nonossifying fibromata) occur in the first decade of life in more than a third of all children.[6,7] The least frequent of the common lesions is the chondromyxoid fibroma with less than 200 reported in the world's literature.[8,9] The giant cell tumor of bone, which in the past has been considered a benign neoplasm with occasional fatal dissemination,[10,11] is excluded from this list. The giant cell tumor is at least "quasi-malignant"[12] and its malignant behavior, regardless of histologic grade, in up to 30 percent of cases[13,14] indicates that it should be approached as a low grade but fully malignant neoplasm.[15]

A much rarer group of lesions, listed on the right of Table 1, are true tumors in the neoplastic sense. All the tumors listed in the "rare" category have been described at least twice in the English language literature. An additional number of exceedingly rare isolated lesions have also been described, but are omitted for brevity.

TABLE 1.—*Benign Lesions of Bone*

Common Lesions	*Rare Lesions*
1. Fibrous cortical defect	17. Hemangioma
2. Nonossifying fibroma	18. Lymphangioma
3. Osteochondroma	19. Osteoma
4. Bone island	20. Lipoma
5. Paget's disease	21. Neurofibroma
6. Unicameral bone cyst	22. Desmoplastic fibroma
7. Bone infarct	23. Ossifying fibroma
8. Myositis ossificans	24. Fibromyxoma
9. Fibrous dysplasia	25. Fibroxanthoma
10. Enchondroma	26. Periosteal desmoid
11. Osteoid osteoma	27. Periosteal chondroma
12. Eosinophilic granuloma	28. Neurilemoma
13. Aneurysmal bone cyst	29. Glomus tumor
14. Chondroblastoma	30. Cementoma
15. Osteoblastoma	31. Hemangiopericytoma
16 Chondromyxoid fibroma	32. Ganglioneuroma

Giant cell tumor is excluded because of its basically malignant nature. Infectious, parasitic and metabolic disease and their associated bone lesions are excluded.

Malignant Potential of Common Benign "Tumors" of Bone

The frequency with which a benign bone lesion may become a malignant lesion varies from zero in the case of osteoid osteoma[1] to 50 percent with multiple enchondromas.[5] The number and diversity of malignant lesions associated with other benign lesions is interesting (Table 2). In Table 2, the list of common benign bone lesions has been condensed from 16 to 14 by omitting bone island and combining the histiologically identical nonossifying fibroma with fibrous cortical defect. The 14 entities can then be arranged into three general categories—acquired, developmental and neoplastic.

TABLE 2.—*Malignant Lesions Associated with Benign Lesions*

Benign "Tumor" of Bone	*Cause*	*Reported Malignancy*
Aneurysmal bone cyst	Acquired	None
Unicameral bone cyst	Acquired	Chondrosarcoma (Grabias and Mankin[21]) and fibrosarcoma, giant cell tumor, osteosarcoma (Johnson, et al[20])
Myositis ossificans	Acquired	None? (Pack and Braund;[22] Shanoff, et al[23])
Bone infarct	Acquired	Fibrosarcoma (Dorfman, et al;[25] Furey, et al[24])
Eosinophilic granuloma	Acquired	Letterer-Siwe? (Lieberman, et al[29])
Fibrous cortical defect	Developmental	None? (Bhagwandeen[34])
Osteochondroma	Developmental	Chondrosarcoma, osteosarcoma (Dahlin[35])
Enchondroma(ta)	Developmental	Chondrosarcoma
Fibrous dysplasia	Developmental	Osteosarcoma, chondrosarcoma, fibrosarcoma, adamantinoma (Cohen, et al[43])
Paget's disease	Developmental?	Osteosarcoma, chondrosarcoma, fibrosarcoma, giant cell tumor
Osteoid osteoma	Neoplastic	None
Osteoblastoma	Neoplastic	None? (Mayer[57])
Chondroblastoma	Neoplastic	Malignant chondroblastoma, chondrosarcoma (Kahn;[59] Sweetnam and Ross[58])
Chondromyxoid fibroma	Neoplastic	Chondrosarcoma (Iwata and Coley;[65] Levy[66])

Acquired Lesions

The cause of an aneurysmal bone cyst is unknown. It is included in this category because of its occasional association with another of the benign tumors,[16] suggesting it may result from degeneration of an underlying lesion and development of arteriovenous fistulae or at least local alteration of hemodynamics.[17]

The unicameral bone cyst and the lesions listed as myositis ossificans[5] are definitely acquired.[18,19] The occurrence of malignancy arising in both unicameral bone cysts[20,21] and myositis ossificans[22,23] has been reported.

Sarcoma has been reported as a complication of bone infarct.[24,25]

Eosinophilic granuloma is of unknown cause. If the concept of histiocytosis as expressed in the past[26-28] is valid then Hand-Schüller-Christian disease and particularly Letterer-Siwe disease[29] might be considered the malignant counterparts as indicated. There is considerable recent opinion to suggest that the contrary is true, however.[30,31] Letterer-Siwe disease may, at times, include lymphomatous disorders.[29]

Developmental Lesions

The fibrous cortical defect is listed among this group[32,33] despite the fact that its occasional evolution into a nonossifying fibroma might suggest that the latter is neoplastic.[5] Malignancy has been recorded in one case,[34] but that occurred within 18 months and the initial x-ray findings were not compatible with a nonossifying fibroma, placing the original diagnosis in doubt.

Chondrosarcomatous degeneration of an osteochondroma occurs in at least 20 percent of cases in the multiple familial type but probably less than 1 percent of the isolated lesions.[1,5,35] The apparent development of two cases of osteosarcoma arising in osteochondroma has been reported.[35]

Both solitary and multiple enchondromata are placed in the developmental group. Although Jaffe is noncommittal about the nature of the usual solitary enchondroma, the multiple types in Ollier's and Mafucci's syndromes are stated to be definitely developmental.[5] Malignant transformation of a single enchondroma is infrequent in large tubular bones,[5] and rare in the phalanges,[1] but has been reported. Spratt's calculation of doubling time of chondrosarcomata suggests that these more slowly growing malignant tumors may be present at birth, or congenital.[37] Chondrosarcoma occurs probably in over 50 percent of cases of multiple enchondromata[5] except in Mafucci's syndrome which has approximately the same incidence of malignant degeneration as the multiple osteochondromata.[38]

The occasional monomelic or ipsilateral distribution of bone lesions and the association of skin pigmentation which is occasionally present at birth indicate that fibrous dysplasia is developmental. Furthermore, the bone dysplasia tends to become quiescent when adulthood is reached, at least in the monostotic type.[39] Osteosarcoma, fibrosarcoma and chondrosarcoma have occasionally developed in bones affected with lesions of fibrous dysplasia[40,41] both in irradiated and nonirradiated bone. About 0.5 percent of cases of fibrous dysplasia will develop a bone sarcoma, 400 times the spontaneous rate.[42] Adamantinoma has also been reported in bones showing lesions microscopically compatible with fibrous dysplasia but separated from them.[43]

Barry[44] tends to reject the hereditary nature of Paget's disease reported by others.[45-49] In patients with Paget's disease, sarcomatous degeneration is expected in fewer than 1 percent of asymptomatic cases[50,51] but in up to 10 percent of symptomatic cases.[5,52] Schmorl[53] and Collins[54] have reported more than a 3 percent incidence of Paget's disease in autopsies of patients over the age of 40 in two large series, so the disease is neither rare nor necessarily symptomatic.[55] New or persistently localized pain, a fracture or a cortical erosion must be considered malignant until proven otherwise.

Neoplastic Lesions

Osteoid osteoma is considered by most authorities to be a benign neoplastic tumor and there is no evidence that malignancy occurs.[1]

Osteoblastoma, which is histologically similar[56] but larger than osteoid osteoma and with a different sex distribution,[5] has had only one reported sarcomatous transformation and with this tumor metastasis did not occur.[57]

Chondroblastoma may have a greater malignant potential than realized.[1] The reported cases of malignant chondromblastoma[58,59] showed no distinguishing histological characteristics to separate them from the usually benign form.[59] A chondrosarcoma developed 3½ years after curettage of a chondroblastoma and administration of 3,600 RADS of postoperative radiation.[60] This case had too short a latent period to fit the cri-

teria of Cahan for postradiation sarcoma of bone.[61] Others, however, have reported latent periods of less than five years.[62-64] It would seem best to exclude internally or externally irradiated patients from reports of spontaneous malignant transformation of a recognized benign tumor to a sarcoma.

Relatively few chondromyxoid fibromata are reported[8,9] and the malignant potential seems low.[9] Chondrosarcomatous transformation has been reported in a few cases.[65,66]

Treatment of Benign Tumors of Bone

In Table 3, treatment options are listed across the top and the "tumors" are arranged into groups based upon recommended treatment. Bloc excision must be understood to include amputation in an occasional case. The word expendable refers to the bone in which the tumor is located, and which can be partially or completely sacrificed without significant functional disability. In fact there are four bones that fit this definition: fibula, rib, clavicle and scapula. Portions of the spine and pelvis, if location is fortuitous, may also be resected with minimum disability. Major resections of pelvis or segmental resections of spine should ordinarily be reserved for truly malignant lesions, but may be required for extensive or recurrent benign lesions.

Lesions That Should Be Observed

Observation is recommended for osteochondromata unless persistent symptoms indicate serious interference with function or malignant conversion. Occasionally, cosmesis is a valid indication for excision. Irradiation is contraindicated because the cartilagenous tissue fails to respond and sarcomatous induction is possible.

Fibrous cortical defects and nonossifying fibroma should be expected to heal spontaneously without complication unless there is a latent pathological fracture, but nonossifying fibroma is less likely to heal and more likely to be the site of a fracture. Either lesion should be curetted and grafted if fracture is imminent.[1] If the lesion presents with a fracture, it should be expected that the fracture, but not necessarily the lesion, will heal.

Fibrous dysplasia should be generally observed, but curetted and grafted if pathologic fracture threatens.[1] Irradiation is contraindicated.[41]

Paget's disease should be closely observed. The pain is responsive to small doses of irradiation[54] and to various medications.[67] If pain is due to malignant degeneration, the prognosis is dismal.[51]

Lesions That Should Be Treated by Curettage and Graft

A unicameral bone cyst should be curetted and packed with graft unless it is in an expendable bone, which is unlikely.[68,69] If the cyst is small or near the epiphysis, observation alone may be acceptable if the diagnosis is histologically certain.[68] The recurrence rate of over 50 percent in the less than 10-year-old age group,[68,69] particularly in males,[69] has been noted in two large series. Chemical cauterization of the cavity is not helpful.[68] The type of graft material seems to be unimportant provided adequate packing of the cavity

TABLE 3.—*Management of Benign Bone Lesions*

"Tumor" Entity	*Observation*	*Curettage*	*Curettage-Graft*	*Bloc Excision*	*Cryotherapy*	*Irradiation*
Osteochondroma	Recommended	.....	.....	Enlarging, SX	.....	Not indicated
Fibrous defect	Recommended	.....	?Latent Fx	.....	.....	Not indicated
Fibrous dysplasia	Recommended	.....	Latent Fx	.....	.....	Contraindicated
Paget's disease*	Recommended	.....	.....	.....	.....	Effective (SX)
Solitary cyst	Active, small	.....	Recommended	?Expendable	.....	Contraindicated
Eosinophilic granuloma	NWB bone, HSC*	Acceptable	Recommended	.....	.....	Effective
Enchondroma	NWB bone, small	.....	Recommended	Expendable or recurrent	.....	Not indicated
Aneurysmal cyst	Contraindicated	.....	Recommended	Expendable or recurrent	?Recurrence	Inaccessible
Chondroblastoma	.....	.....	Recommended	?Expendable	.....	In adult?
Osteoblastoma	.....	.....	Recommended	Expendable	.....	Inaccessible
Chondromyx fibroma	.....	.....	.....	Recommended	.....	Unknown
Myositis ossificans	"Immature"	.....	.....	"Mature"	.....	Not indicated
Osteoid osteoma	Asymptomatic	Acceptable?	.....	Recommended	.....	Ineffective
Giant cell tumor	.....	.....	.....	Recommended	.....	Inaccessible

*May respond to drugs.

Fx = fractures
HSC = Hand-Schüller-Christian disease
NWB = bones not bearing weight
SX = symptoms

is achieved.[69] Irradiation is ineffective[1,5] and contraindicated because of damage to the epiphyseal plate in children and potential for subsequent sarcoma induction at any age.

The eosinophilic granuloma is also best treated with curettage and graft. If the lesion is in a bone not bearing weight, or is a second lesion of Hand-Schüller-Christian disease, simple observation is indicated. Radiation is effective at a dose of 300 to 600 RADS,[29] but the lesions heal without either surgical operation or radiation (the author has seen a massive lesion of the iliac bone heal completely following curettage alone). Prognosis for survival is excellent if only the skeleton is involved.[70]

Enchondroma is another lesion which is best treated by curettage and graft unless it is small and in a bone not bearing weight. In this event the lesion must be closely observed because of the possible misinterpretation of biopsy material which can resemble low grade chondrosarcoma. The reverse is also true.[1] The low recurrence rate following adequate surgical procedures and the low rate of malignant transformation of solitary enchondroma does not indicate bloc excision but this is an acceptable option in an expendable bone. Radiation is probably ineffective.[5]

The aneurysmal bone cyst can be massively destructive[17] and observation is contraindicated unless antecedent radiologic inactivity or regression is noted in the lesion. Medullary or cancellous lesions should be treated by curettage and graft although some lend themselves to local excisions.[1] Massive intraoperative blood loss can occur in these lesions. En bloc excision is quite acceptable in an expendable bone and can minimize bleeding. Cryotherapy has been successful.[16,71] Radiation might be used in treatment of the aneurysmal bone cyst in an inaccessible location and is reportedly successful at a dose between 2,000 and 3,000 RADS.[72]

Another lesion that is best managed by curettage and graft is benign chondroblastoma.[73-75] En bloc excision of an expendable bone or of a recurrence is acceptable.[1] Radiation is effective and acceptable after closure of the epiphyses[77] but the risk of sarcoma induction should be considered.[60]

Osteoblastoma should also generally be managed by curettage and graft, or possibly with bloc excision if located in an expendable bone. Radiation has occasionally been successful and is acceptable in inaccessible locations, or if surgical operation is refused or contraindicated.[5]

Lesions That Should Be Managed by Bloc Excision

It is recommended that chondromyxoid fibroma be managed by bloc excision as suggested by Spjut and co-workers,[1] Schjowicz,[9] Copeland[77] and Ralph.[78] The recurrence rate following curettage is as high as 25 percent[35] and there is evidence that this lesion has a slight malignant potential.[66] The effect of radiotherapy is unknown.[1]

The rather common but improperly named myositis ossificans[79,80] is classically managed by observation while it is "immature" and excision when "mature," if indications for surgical operation are present.[81] Exactly what constitutes immaturity and maturity and what surgical indications exist may be difficult to determine in a given case. Rest of the involved part in the early case is said to lead to absorption of the lesion,[81] but there is little evidence to support one particular course of management.

Symptomatic osteoid osteoma is best managed by bloc excision,[1] but curettage of the nidus may be acceptable in some locations provided removal is complete. These lesions may be self-limiting[82] and are occasionally asymptomatic.[83] Radiation is ineffective.[5]

Giant cell tumors are included in this list of benign tumors to emphasize that they may behave in a malignant manner and histologic grading correlates poorly with the prognosis.[13] Curettage results in recurrence in over half the cases and en bloc resection is strongly recommended.[84-86] Radiation is not always effective but perhaps is acceptable for inaccessible tumors.[13] In electing primary or supplemental radiotherapy there may be significant induction of a malignant giant cell tumor[14,87] and this type usually contains the more anaplastic lesions.[14]

Summary

Clinicians occasionally face the problem of optimum management of a bone lesion. Thorough clinical evaluation and careful radiographic study may allow diagnosis of lesions due to inflammatory, development, metastatic or metabolic processes. Even excluding these categories, there remains a large group of lesions which are listed in Table 1. These are related to their malignant counterparts in Table 2. Table 3 rearranges the most common of the benign tumors into groups for which a recommended plan is suggested, predicated of course upon reliable diagnosis. The

complexity and variability of histopathologic material makes interpretation difficult even in the hands of an experienced pathologist. Misdiagnosis is most often due to the failure to correlate all pertinent data in a tripartite discussion by clinician, radiologist and pathologist, as reemphasized most recently by Woods.[88]

The schema (Table 3) is presented as a guide but each lesion still requires individualization of management based upon age of the patient, location and extent of the tumor, consideration of the malignant potential, the surgeon's experience and capabilities, accessibility of supportive consultants and the patient's wishes. Treatment based upon overdiagnosis of the benign tumor or underdiagnosis of the malignant tumor is likely to result in a tragic outcome.

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Thromboembolic Problems

Identification of the high risk patient—the patient who is likely to have thromboembolic complications:

Surgical patients at greatest increased risk unfortunately are a large segment of our population. They are: patients over 40 years old with any type of heart disease—even well-compensated heart disease; those over the age of 50 with cancer; patients who are 20 percent or more over ideal weight; patients with ulcerative colitis; particularly those in whom major operative procedures in the lower abdomen have been done (this is more so than those having had upper abdominal work and more so than those having upper extremity or head and neck problems); women who have been on the pill and come in to the hospital even for minor procedures. (There are some very good data now out of England with ^{125}I fibrinogen showing an increased risk of about fourfold in that group. So, it's probably wise, when you can, to put these patients on some other form of contraceptive at least a month before the operative procedure.)

—WILLIAM W. COON, MD, *Ann Arbor*

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